JANUARY · 1941

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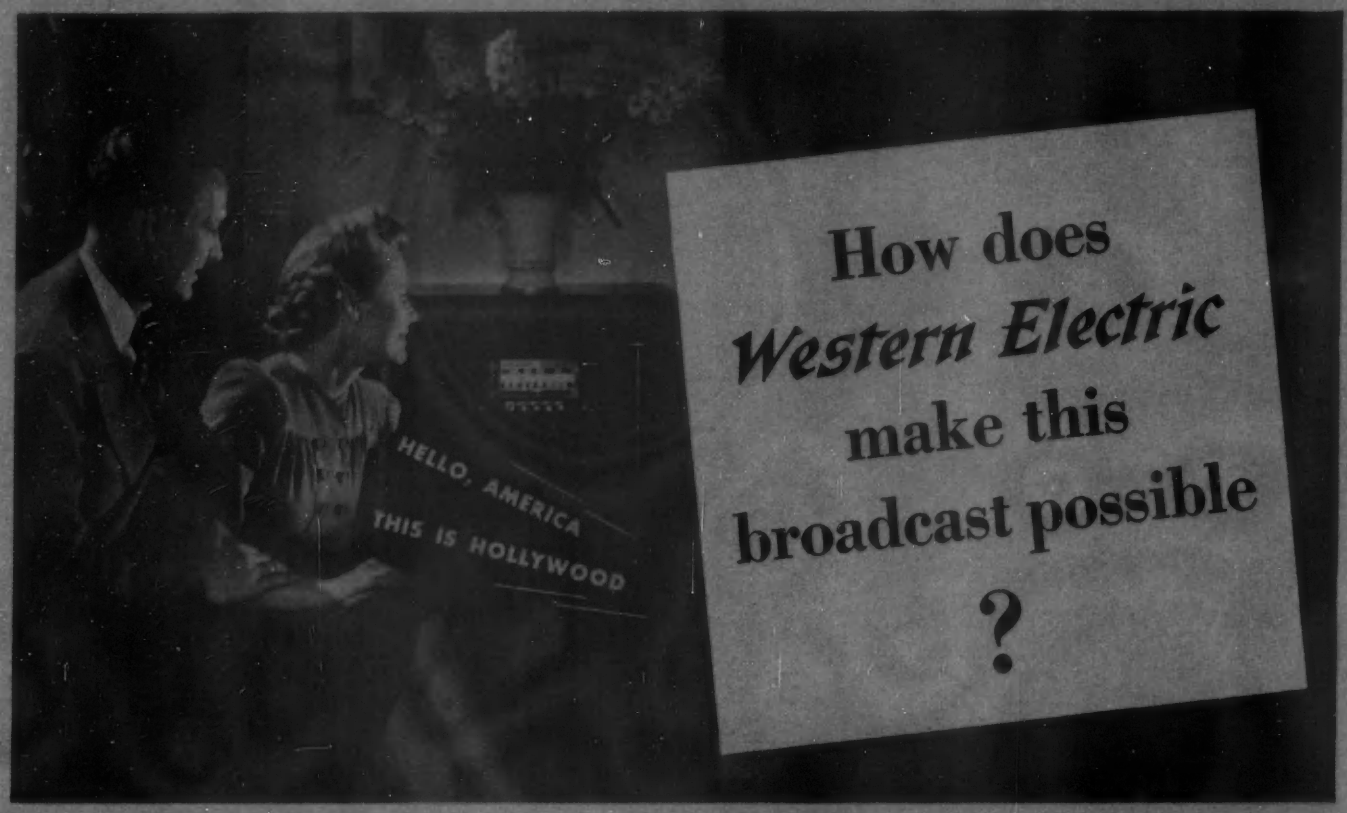
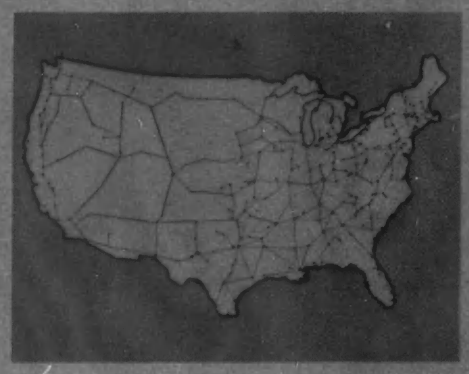
THE TECH ENGINEERING NEWS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

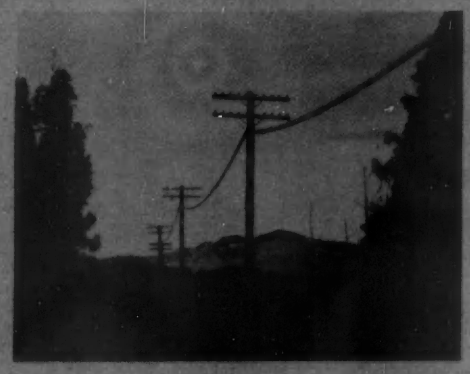


How does *Western Electric* make this broadcast possible ?

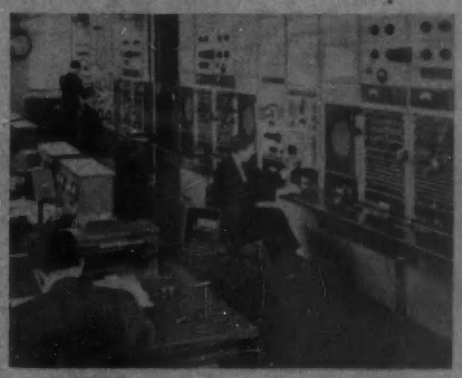
In the development of radio—that important influence in modern life—Western Electric equipment has played a big part.



Here are the main routes of the high quality Bell System lines employed in broadcasting service. The "network broadcast" travels over these wires.



The thousands of miles of wire and cable, the poles, the countless items of apparatus were supplied by Western Electric, manufacturer and purchaser for the Bell System.



Telephone company control offices like this one, Western Electric equipped, are located at important cities. They switch the network program to selected broadcasting stations.

To keep the program at full brilliance, Western Electric [illegible] tubes at "repeater stations" amplify the electrical impulses with complete fidelity.

So, out of the telephone art has come much of broadcasting's plant. This apparatus is made by Western Electric with the same skill as your Bell Telephone.

Western Electric

. . . is back of your Bell Telephone service

THE TECH ENGINEERING NEWS

JANUARY · 1941

OUR COVER THIS MONTH

Airliner poised for an early morning take-off.

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NUMBER 8

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WHAT PRICE AIR POWER?

AN UNEASY PUBLIC SEES THE NEED FOR A STRONG AIR FORCE AND HOPES THAT AMERICA IS EQUAL TO THE TASK

By REED G. LANDIS

REGIONAL VICE-PRESIDENT, AMERICAN AIRLINES, INC

IN December, 1903, two simple Ohio boys, aided by their sister, built and flew the first successful power driven airplane in the world. That is less than thirty-seven years ago — less than most of us have lived. The baby was not premature — but it certainly would never have taken a prize at a baby show. For the first eleven years of its life it stayed puny — largely because its parents were unable to provide proper nourishment.

In 1914 the little one dropped his swaddling clothes and put on rompers. He also picked a fight with other tough eggs in the neighborhood and did pretty well. The exercise of fighting, and the improved diet provided by his fighting management, aided him to grow more in the four years of war than in the entire period before. While we still flew "strange contraptions of sticks, wires and rags," we flew — and did our military jobs with a surprising degree of performance.

When Armistice came, tens of thousands of airmen and aircraft found themselves out of a job. Many of those men were so sold on aviation as to be the modern equivalent of Crusaders. In one way or another, some of which can better be passed over, they wangled gas and oil for their old crates, and hamburgers, hot dogs and pop for themselves — and built a barnstorming business all over the country. From that struggle gradually emerged one flying field after another — and an occasional hangar or two — and some of the barnstormers settled down and became fixed base operators, selling joy hops, student instruction, special charter flights across country — and anything else which might bring in a more or less honest dollar.

While this was going on, the Post Office Department was building the foundation of scheduled air transport via the early air mail operations. First flown only by day and in good weather, the art progressed rapidly until finally we had a transcontinental line, with service day and night.

It was in 1926 that the President decided the experiment had proven sufficiently successful to justify its continuance on the typical American basis of private enterprise. That was when the first airline companies were organized and the first air mail contracts placed.

For several years only mail was carried and the network of airways gradually and rather slowly grew to embrace most of the principal centers of the nation. Community after community bonded itself for airport construction and brought the new business and social tool to the hand of its citizens. Those communities and the civic leaders whose vision and energy made the program possible deserve a place in the Hall of Fame.

The early air mail carriers were not interested, generally speaking, in carrying passengers. Mail bags and express could be jammed into tight corners. They required no ventilation, no comfort, no station facilities, and in those early days we earned more from a pound of cargo than from a pound of passenger. However, the advantages of air travel were so obvious to some business men that they plain fought to fly — and a start was made on the provision of passenger service.

Again it was the Government that forced another major change in airline activity. During Mr. Hoover's administration the Post Office Department ordered air mail companies to build passenger and express service to the end that gross income could be built up and air mail subsidies reduced. That was the real start of our present day outstanding service. How well it has worked is easily demonstrated. Not ten years ago, the gross income of a typical airline was probably 90 per cent air mail pay and 10 per cent from other sources. In 1939 the gross income of American Airlines was about 30 per cent air mail pay and 70 per cent from other non-Governmental sources. It is even better this year, and I believe that in 1940 the Government will receive more money for air mail postage than it will pay all airlines for the carriage of the air mail. There is no subsidy left in that picture.

This is, of course, pleasing to us in the business. It means we are now in the ranks of self-supporting, American-style businesses earning our way, and a profit, by providing valuable, salable service. How valuable and salable that service now is can perhaps be best understood when I tell you that our passenger measuring-stick showed an increase of 81 per cent this March over March of 1939. The demand increased even more than that, as all airlines were unable to accommodate all who wanted to fly on many of the schedules. This is embarrassing to us. We are doing all we can to expand our service, but it cannot be done overnight. In 1939 American Airlines alone ordered about $8,500,000 worth of aircraft — nearly double the fleet with which we operated in 1939. Those ships are, of course, the latest available and include both 21 and 40 passenger types. Delivery should be completed by late next winter. I firmly believe that by that time we will have more ships on order.

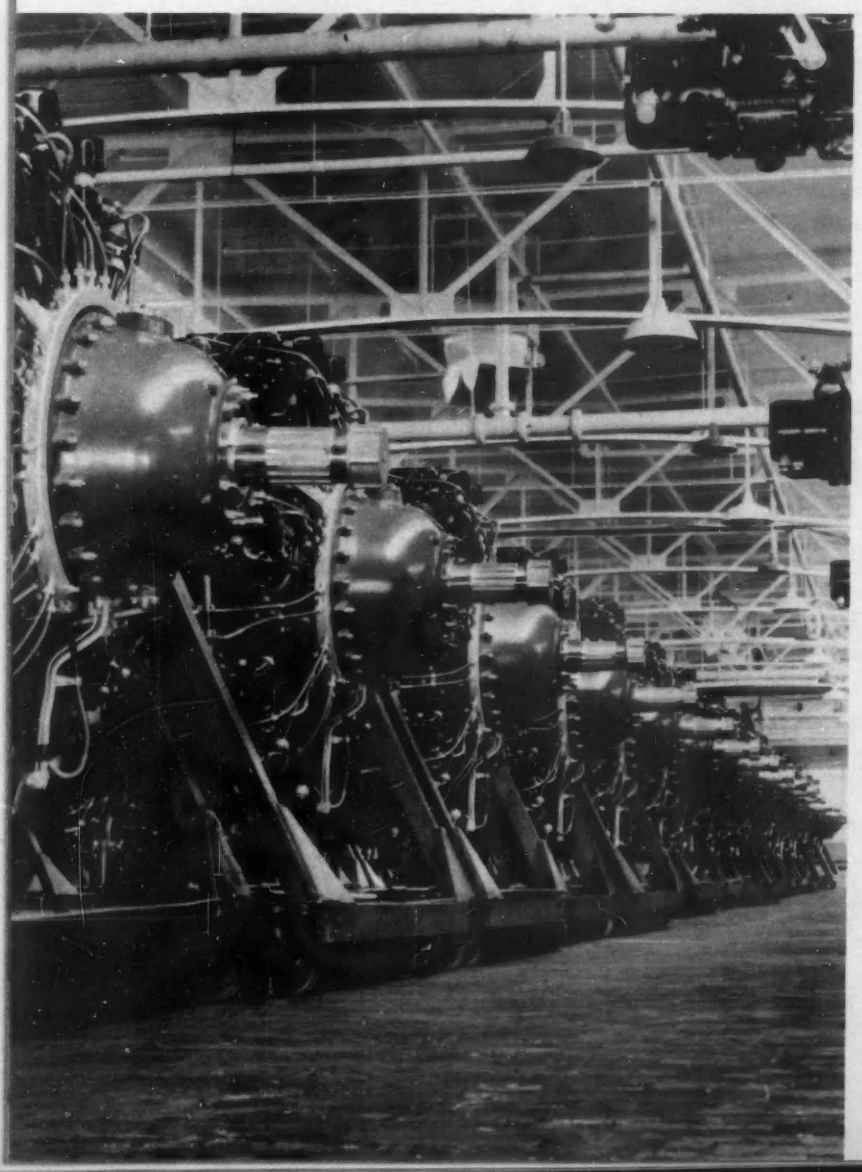
Airplanes are not the only problem in expansion, by a long shot. We insist on safe operation — and we will not lower the high quality of our service to our passengers. Additional schedules mean more room, equipment, and people in sales, reservations and operations departments. Those people must be selected, sent through our own schools, and broken in in the field. And then there is the vital question of pilots. Here our conservatism reaches its peak. We hire no new pilots

who do not already possess outstanding natural qualifications and a great degree of experience. We then put those men through our schools. Following this, they become First Officers and fly at least two years before we place them in command of a flagship. Because Government regulations allow a pilot only eighty-five hours of airline flying per month, we have a non-elastic limit per man. We will expand our services just as rapidly as we can, but you may rest assured that we will institute no program not conservatively premised on safety and service.

While the civil aviation activity has been growing up to virile young manhood, military aviation has been mushrooming at an amazing rate. Some of the World War aviation Crusaders stayed in military service or undertook to design and produce military aircraft. Great believers, like General Billy Mitchell, stuck out their necks so far on prophecy as to wreck their professional career. It seems to me that this is a most excellent time to remind you that the fundamental cause of Mitchell's court martial was his forceful support of his forecast of exactly what has recently transpired in Europe. It is regrettable that he died before his bad dream came true to confirm his wisdom.

Over one hurdle after another military aviation built itself a place in the war councils. It has long been my personal opinion, predicated on my own World War flying experiences and an active interest in the matter since 1919, that no war can be won without control in the air, and that probably control of the air can win a war almost alone. It would take hours to discuss the fascinating facets of that question.

The Army is already air minded. One of the most encouraging factors in this regard is the whole-hearted support given Army aviation by General Marshall, our Chief of Staff. The General knows modern warfare and he will turn out just as good a fighting machine as time and money permit.



Again as an individual, I want to endorse the President's preparedness program. I have long believed that the best defense was to be so strong that no combination of possible enemies would dare attack. It has been proven impractical to count alone on the Golden Rule in international relations. And if war does come to us I want your son and mine to avoid the needless hazards and hardships we suffered due to lack of preparedness.

The whole question of air power is a most interesting and involved one. The foundation stone must be good design — which means properly educated and experienced people with extensive facilities for research. There must then be factories and machines and raw materials and people to work them together. Airplane construction is highly skilled work. There is a tremendous percentage of labor in a given aircraft. It may be years before we can train enough artisans to reach a production of fifty thousand planes a year. On the other hand, ingenious brains, like Bill Stout's in Detroit, are working on most promising schemes for use of new materials and methods, which, if successful, will simplify production to an important degree.

After the airplanes and motors and instruments and radios are designed, tested, and built, we need men to maintain and fly them. This is another bottleneck. It takes months to make a good aviation mechanic and no less time to turn out an embryonic war pilot. The tempo of modern warfare does not allow that work to be done after war starts. A nation must have its defense ready at the outset or be defeated. Fortunately, the average American is somewhat of a tinkerer. He catches on to mechanical things quickly. We have an edge in that regard, if we will but use it.

This year has proven another of the old Crusader's theories. The armed services have always trained their own pilots completely. Now a program is successfully and economically progressing, based on civilian schools providing primary instruction with the Army and Navy supplying the finishing touches. There is an excellent chance to train more pilots to a degree of war-time proficiency than to make the aircraft they require in the same period of time.

Present facts indicate that we need about 12 men on the ground maintaining aircraft for each pilot in the air. 50,000 pilots would therefore necessitate 600,000 mechanics. About one in five of them need not be highly skilled. This means half a million real aviation mechanics are needed and we now have about 40,000 in the Army. The total personnel problem is tremendous and of vital importance.

We have already learned some lessons from the air fighting in this war. We know that we must provide cannon instead of machine guns for use in attacking large aircraft. It is reliably reported that one German bomber brought down in Scotland contained over 20,000 bullet holes. We must provide some armor — to force our enemy to use large guns and to reduce his chance to destroy our craft and people. We need self-sealing fuel tanks so a single bullet cannot bring a great war plane to the ground by fuel exhaustion or fire. And we need lots of aircraft, airmen and supplies so we may impose our air power with effective impact to do the job.

While war is not pleasant to contemplate, it is better, in my opinion, to fight one and win it quickly than to have it drag out and perhaps be lost. It is perfectly possible that the seeming extravagant use of people and things, if successful, will prove most economical in the long run.

Boeing Aircraft

SUB-STRATOSPHERE FLYING OFFERS THE PASSENGER THE LATEST IN AIR-CONDITIONED COMFORT

By L. G. FRITZ

VICE-PRESIDENT TRANS-CONTINENTAL AND WESTERN AIRWAYS, INC.

CONSIDERABLE technological improvements have been made in air transport planes during the past ten years, resulting in greater safety, performance, passenger comfort, and convenience. The heating and ventilating system has always been a major problem inasmuch as passenger comfort is directly related to comfortable cabin temperatures and ventilation. Consequently, the heating and ventilating systems of air transports have been greatly improved during the past ten years.

Ten years ago, heating and ventilating was considered of more or less secondary importance. The fresh, cold air was taken in through small "horns" located at each seat, these horns extending through the fuselage to the outside. They were designed so they could be turned to take in the desired amount of air or turned up or back to stop the flow of air. Naturally, considerable noise, vibration, and quite often fumes from the engines were encountered, but at that time it was considered by most people as just part of air travel. No spent air or ventilation valve was provided to help control the amount of foul or used air escaping from the cabins. Leaks, which were usually plentiful around doors and windows, were depended upon to take care of this problem.

The conventional heating system of ten years ago usually consisted of a metal shroud covering the exhaust tail pipe. This tail pipe was ordinarily on the under side of the plane and quite often extended almost the full length of the cabin in order to obtain sufficient heat. The air entered the duct thus formed at the forward end between the exhaust pipe and the shroud, and after passing along the hot exhaust pipe, was admitted to the cabin through adjustable sliding valves in the aisle between the seats, or through tubular ducts along each wall near the floor.

Admittedly poor circulation, and quite often inadequate heat, were obtained with this arrangement, yet it was many years before it was changed. The admittance to the cabin of exhaust gases and carbon monoxide were always feared from broken exhaust pipes and loose connections, and we sometimes wonder now how the airlines operated as long as they did without more serious trouble from the hazard of asphyxiation and fire in the cabin heating systems of that period.

In 1933, when the Douglas Company built the DC-1

for Trans-Continental and Western Airways, Inc., the first cabin steam heating system of which we have record was installed for airline use. The system was of the low-pressure type, operating under only a few pounds pressure. The water entered the boiler, which was located in one engine nacelle, at the bottom, by gravity feed, and went out at the top as steam to the steam radiator, which was located in the fuselage below the cabin floor. Cold air, picked up at the nose of the plane, was directed by an electrically operated, automatic temperature control either through the steam radiator or around it, depending upon the cabin heat demand. After this first DC-1 steam heating system, fast strides were made to the present-day heating and ventilating system as we have it in the Stratoliner.

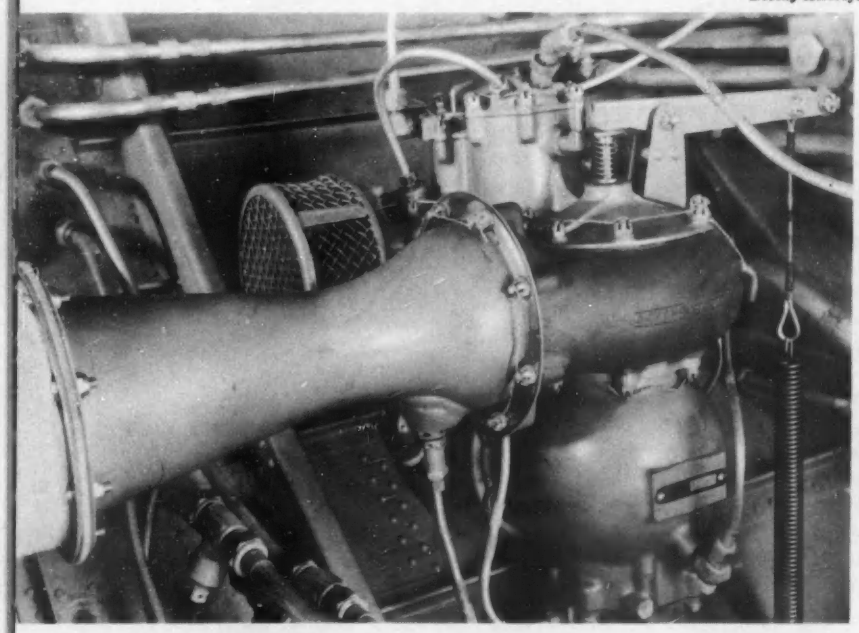
The heating and ventilating system of the Stratoliner consists, actually, of five separate, though intimately related, systems. They are (1) Fresh Air System, (2) Spent Air System, (3) Warm Air System, (4) Steam System, (5) Ground Conditioning System.

Fresh air is supplied to the cabin by means of an air scoop on the upper side of the fuselage through which air is forced by the forward speed of the airplane into a distribution duct which extends the full length of the passenger cabin and which is located on the ceiling. This is divided longitudinally into two sections, the lower of which contains grills through which air is distributed directly into the cabin, while the upper section is a supply duct for the individual outlets which are located at each seat and upper berth. The individual outlets are also provided in the ladies' and men's dressing rooms and other sections of the plane forward of the passenger cabin.

After the air enters the scoop, it passes through a centrifugal water separator device which is an integral part of the duct just inside the fuselage skin, and which is intended to prevent water from being forced into the distribution duct in the cabin. There are two valves located in the outlet duct behind the water separator. The foremost of these valves is used for closing the air inlet during the time the cabin is supercharged or during extremely cold weather, when the fresh or cold air is not necessary. It is operated from the cockpit by means of a lever on the floor behind the First Officer.

Heart of the "altitude conditioning" system of the Boeing Stratoliner is the cabin supercharging control

Boeing Aircraft



The rearmost valve controls only the flow of air through the lower section of the ceiling duct and can be operated only from the control on the front bulkhead in the passenger's cabin. Thus the Flight Engineer, who controls the cabin supercharging system, determines the source of all air entering the cabin but cannot control the distribution of it; the hostess in the cabin determines the distribution of the air but cannot control the source.

The individual ventilator nozzles located in the wall next to each seat and within each berth, have both a directional and a volume flow adjustment which is formed by a ball-and-socket made of sound-deadening plastic material. Each nozzle may be adjusted to release a high velocity air jet in order to obtain maximum air re-circulation effect. A rubberized, fabric hose connects the individual ventilators to the main supply duct and is concealed behind the cabin lining.

The spent air is exhausted into the lower fuselage section below the cabin floor through vents in the floor, which are located under the seats and so arranged as to give even distribution throughout the cabin. The air is discharged from the airplane through either an auxiliary outlet valve, or through the supercharger control units, or both. The auxiliary outlet valve is located in the lower covering of the airplane just aft of the front spar bulkhead in the accessory compartment and is manually operated by the same lever which is used to operate the fresh-air, inlet valve.

Cabin Supercharging and the Warm Air Supply

The pressure, air supply, control, and temperature conditioning system is provided in duplicate, there being one system on each side of the airplane, either system being capable of maintaining satisfactory cabin temperature and pressure should the other system fail.

All doors and hatches open inward and therefore are sealed against rubber gaskets under the influence of cabin pressure. The skin or fuselage-covering continuity is not broken at the intersection with the center section of the wing and forms a cell which is circular in section, cigar-shaped in form. There are 17 passenger compartment windows measuring 12 inches high, 16 inches wide, the panes of which are a single-ply section of $\frac{5}{16}$ inch Plexiglas. Plexiglas was chosen for its high strength-weight ratio. The cabin is designed to withstand six pounds per square inch internal pressure, even though the maximum internal working pressure intended for transport operation at our present optimum altitudes is but 2.5 pounds per square inch.

The cabin floor level is located somewhat below the center line of the fuselage at its largest section. The cargo compartments and the accessory compartment between them under the floor are maintained under full cabin pressure and are part of the circulatory system. The fuselage is pressurized only to the rear end of the cabin, and at that point there is a removable circular hatch in one side of the hemispherical bulkhead to enable inspection of the interior of the tail of the airplane. An emergency air valve set to relieve at a pressure of 2.65 pounds per square inch is also located in the bulkhead as a safeguard against building up excessive internal pressure. This valve has a capacity equaling the totally overloaded discharge of both cabin superchargers at sea level and during maximum supercharger speed, without causing the cabin pressure to exceed 3.6 pounds per square inch.

This airplane carries a Flight Engineer as part of the flight crew, one of his duties being to handle the cabin supercharging. His station is behind the co-pilot and he has an instrument board in the side wall of the

(*Continued on page 352*)

TECHNOLOGY'S WIND TUNNELS

THE INSTITUTE'S AERODYNAMIC RESEARCH HAS BEEN SECOND TO NONE SINCE THE TURN OF THE CENTURY

By WILLIAM HEYSER, '44

THE first wind tunnel in America was constructed by a student named Wells at the Tech on Boylston Street in 1896. Used for research on a thesis, "Wind Pressures on Surfaces," a blast tapped from the ventilator system gave its three-foot square throat an air speed of sixteen miles per hour.

In 1913, a course in aeronautical engineering was established at the Institute, the first in the country. Soon after, a new and larger tunnel was built under the direction of Jerome C. Hunsaker, present head of the Department of Mechanical Engineering. Being similar to the apparatus of the National Physical Laboratory in England, the experimental chamber was four square feet in cross section, and had a maximum air speed of thirty miles per hour. With the same motor and equipment, this old timer was remodelled by E. P. Warner, Instructor, to form a four-foot circular Venturi-type tunnel. Housed next to the Cape Cod Canal Hangar, it is still in use by seniors in Course XVI.

1922 saw the completion of a seven-and-a-half-foot circular throat tunnel with an airspeed of 82 miles per hour powered by a 100 horse power motor. Also designed by E. P. Warner, it was constructed in the Cape Cod Canal Hangar before the canal itself, and later moved to the basement of Building 33. In order to facilitate this moving, the side wall of the basement was not erected until afterwards. This tunnel was torn down in the summer of 1940; another now under construction will take its place. Five years later, a very small tunnel (150 miles per hour airspeed) was designed by Edward S. Taylor, Associate Professor, for use in heat transfer studies. It is still in use in the automotive laboratory.

The next wind tunnel at M. I. T. was the 1929 Venturi open-return model designed by Professors S. Ober and J. R. Markham, and has now been turned over to student use in the basement of Building 33. This was one of the first systems to use a six-component wire balance with automatic beams, innovated by Dr. Prandtl at the University of Göttingen, Germany.

Dismantled in the summer of 1940 was the rather small wind tunnel (throat of three feet by one foot) specifically designed for boundary layer research in 1935 by Dr. H. Peters, a student of Dr. Prandtl. With this type of equipment, air measurements were made on extremely smooth flat plates under varying pressure gradients to determine the fundamental nature of air resistance. Boundary layer or "skin friction" refers to that thin layer of air on a moving surface which moves from rest at the body surface to the stream velocity outside. An unusual feature of this 1935 apparatus was the "hot wire anemometer," a heated platinum wire about one ten thousandth of an inch in diameter which measured the air velocity electrically by its varying resistance due to its change in rate of cooling.

Built at an approximate cost of $350,000, the Wright Brothers Wind Tunnel was dedicated "as a memorial to the experimental methods of the Wright Brothers" in September, 1938. The largest of all wind machines at M. I. T., it is essentially a closed, welded cylindrical steel circuit with a blast of air powered by a 2,000 horse power motor attached to a six blade propeller.* The previously described wind tunnels had all been made of reinforced plywood. This comparative cyclops is the only one in the country, aside from two government tunnels, which features a variable air density system. With the models used, air within can be compressed to certain pressures which simulate full scale flight, or exhausted to one-fourth of an atmosphere — the conditions of the stratosphere. The balance system designed by Professor Markham at the time of building is unique and still rates very highly. By this is meant the rigid "pyramid" balance system to which the model or wing section is attached so as to allow it six degrees of freedom. Completely enclosed in the elliptical (ten

* For further details, see December 1938 issue of TECH ENGINEERING NEWS.

(*Continued on page 349*)

The crescent-shape vanes which guide the high-velocity wind stress around the corners in the Wright Brothers' Wind Tunnel

AIRLINE ENGINEERING COMES OF AGE

INCREASED AIRLINE TRAFFIC REQUIRES THE APPLICATION OF ENGINEERING SKILL

By R. DIXON SPEAS, '40

AMERICAN AIRLINES

UNTIL recently the members of the engineering department of any one airline in the country could be counted on the fingers of one hand. The airline engineering departments were considered as necessary only for the direction of maintenance of aircraft and accessories designed and supplied by the manufacturers. Today, however, greatly expanded forces of the airline engineering departments are assigned duties of drawing up specifications for new aircraft, determining (by calculation and actual tests) the desirability of different types of available flying equipment, making exhaustive tests to determine the most satisfactory operating technique for flight equipment, choosing between different types of engine and aircraft accessories, and performing other tasks that befit the engineering department of a transportation company.

Instrument overhaul

The personnel policy of the airline engineering departments has also undergone considerable change in recent years. Formerly the airlines hired only those engineers with previous experience in the aeronautical fields of manufacture or research. Today, however, several of the airlines are hiring graduates of the engineering schools, and training the young engineers to the varied tasks that confront the airline engineer. During this introductory period of his employment, which may last one or two years, the apprentice spends a large amount of time in the different maintenance shops where he becomes acquainted with the problems of the men who will in the future be following his directions on engineering projects.

In considering the tasks that will face the airline engineer after his training we find that his duties will be interesting and diversified. A policy of project assignment is followed in the engineering department, and a large amount of latitude is given the engineer as to the methods to be used in accomplishing his tasks. Assignment of projects is such as to provide some opportunity for general specialization along such lines as structures, power plants, engine accessories, flight analysis, and ground equipment. The assignment of projects is made by the Chief Engineer in such a manner as to obtain a balance between diversification and specialization.

A good portion of the engineering department's time is taken up by the engineering of changes on aircraft in operation. From results of research and operation experience it is often realized that for economic or other reasons changes are advisable on aircraft in operation. A change may be as simple as adding a light in the cargo compartment or it might consist of some revision in the structure of the airplane (such as the addition of a bracing member to the engine mount). The engineer must determine the most efficient way in which the desired change can be accomplished, and then direct the drawing up of plans to be followed by the men in the overhaul department.

Another function of the airline engineering department is the establishment of specifications for flight equipment. The desired combination of performances in a new airliner (as possible under the existing stage of development of the aeronautical art) must be chosen to provide equipment that will fill the needs of the operating airline. These needs will be determined from consideration of length of flight to be made, volume of traffic to be carried, conditions of competition (example — will it be necessary to provide extremely luxurious or fast aircraft to meet competition?), and the types of airports along the routes to be flown. Decisions concerning these specifications of flight equipment have become of paramount importance to the success of an airline, and the engineers must have knowledge of aeronautical development as well as be conscious of the needs of his airline in order to efficiently function in an advisory capacity during the purchasing of flight equipment.

Other specifications must be written to cover non-flying equiment of an airline. Tractors must be

Radio room *American Airlines*

obtained for handling of aircraft on the ground, air conditioners must be had for conditioning the cabin air of planes while they are on the ground, and trucks as well as carts are necessary for handling luggage, mail, and express transfer from city and terminal to plane. This equipment and many other items necessary in running an airline on the ground must have slightly, or in some cases drastically different characteristics from the equipment available on the open market. These differences must be covered in specifications drawn up by a project engineer and submitted to manufacturers with requests for bids. After the various manufacturers indicate the basis on which they will make contracts for the desired equipment, the investigating engineer must determine which manufacturer will be able to supply the airline with the most desirable combination of product and price.

In dealing with ground equipment the engineer may allow several extra pounds to be built into a hoist or truck, but in dealing with items that go into the structure or accessories of flight equipment the situation is quite different. It has been estimated by economists that a pound saved in the empty weight of an airliner is worth $20 a year (through increased payloads) in the operation of each individual plane, while a pound added to the empty weight of an airliner costs the airline approximately $20 a year (in lost cargo loads and passenger traffic). With from 50 to 85 airliners in each fleet of the larger airlines it can be seen that weight control must be carefully exercised over any revisions to the airliners. Continuous research is also conducted for ways and means for efficiently reducing the airliners' empty weight.

While practicing weight control the engineer must also remember the problem of balance control. The weight of an airplane must be distributed in such a manner as to insure the proper flight characteristics. In order to meet this situation, limits for center of gravity position are established and charts are prepared for the loading of the airliners. These charts advise the loading agents as to how much cargo (or ballast if necessary) must be placed in the different cargo compartments in order to maintain the proper location of the center of gravity. The charts must be arranged to cover all possible numbers and locations of passengers aboard the airplane, and must be checked and revised periodically as weight is added to or taken off the airliners by the overhaul shops.

Another phase of airline engineering constitutes the physical and chemical testing of various components of aircraft and accessories before they are placed in regular operation. Chairs must be statically tested under load, fuels and oils must have certain chemical characteristics to meet the airline's specifications. The tests to determine physical and chemical characteristics must be devised and either conducted or supervised by an engineer. Other physical testing serves to indicate comparative performances of aircraft accessories, such as: Fuel Pump "A" versus Fuel Pump "B."

The materials section of the engineering department has charge of the chemical analyses that are conducted on fuels, compounds, and other materials used by the airline. Another function of the materials section is the supervision of oil refining. The refining of drained oil from aircraft has proven to be worthwhile for the airlines, but its operation must be closely supervised. The chemical engineers must direct the actual refining of the oil as well as conduct exhaustive analyses on the refined oil before it is allowed to go back into service. Specifications on refined oil are as stringent as the specifications for new oil.

Also in the "Test" division is the airline's continuous program of flight research. Certain performance standards have been established by the airlines and the controlling governmental agency and must be met by airliners in commercial operation. It is the task of the flight research department to see that the flight equipment of the airline is always such as to be judged air-

(*Continued on page 348*)

Electrical instrument test panel *American Airlines*

THE PUBLIC SAID

DELICIOUS, LOW-COST MEALS, *served in a beautifully appointed dining-car, are among the many attractive features of travel on Budd Sleeper-Coach trains.*

SMART TAVERN *and observation-lounge cars for the use of every passenger on the train—at no extra charge. The day-coach fare buys all this luxury.*

SPOTLESS WASHROOMS, *spacious and luxurious, are found on every Budd-built Sleeper Coach. Finer washrooms cannot be found on any train in America.*

A RESERVED SEAT *for each passenger. A deep-cushioned reclining chair, adjustable to several positions. For rest and quiet at night, lights are dimmed.*

so New York to Florida Sleeper-Coach Trains Are Doubled in Capacity

THE first Budd-built Sleeper-Coach train between New York and Florida went into service in February, 1939. Actually, the Seaboard was presenting an idea to the public—an idea of fast, safe, luxurious travel at day-coach fares. And the train it chose to do the job was as unique as the idea itself. It was a train conceived, designed and built for fastidious people who were eager to travel without unnecessary extravagance.

Each Sleeper Coach provided individual reclining seats, reserved in the passenger's own name. A luxurious lounge and observation car for the use of all passengers. A beautiful dining-car where tasty meals were offered at low prices. Large, carefully appointed lavatories and toilets unexcelled on any American railroad train. All this — plus a host of new refinements.

What happened? So great, so spontaneous was the response that in December Seaboard added two more Budd Sleeper-Coach trains, and the Atlantic Coast Line and Florida East Coast each put two in service, one of them operating between Jacksonville and Miami.

And now, Seaboard has doubled the capacity of its Silver Meteors. Atlantic Coast Line has doubled the capacity of the Champions. Six complete, 14-car trains give daily service in both directions between New York and Florida.

And every one of these trains has that extra margin of safety that is a "must" in all Budd-built equipment. Construction *throughout* is sta nless steel, the strongest known material suitable for structural purposes. Fabrication is by means of the exclusive SHOTWELD★ process.

The success of the Sleeper-Coach idea is a matter of simple arithmetic:

A Sleeper Coach with all seats filled at day-coach fares yields more revenue to the railroad than any other type of sleeping-car equipment . . . and experience proves that the seats will be filled!

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EDITORIALS

EXEUNT

With this, our last issue, the members of the Managing Board of Volume XXI relinquish their posts to their successors of Volume XXII.

The TECH ENGINEERING NEWS has come of age this last year. During its twenty-one years of publication the magazine has recorded many of the forward steps in the engineering and scientific fields that affect all of us in one way or another. We leave to those that come after us the task of presenting further advances in these fields on the printed page. We hope that the record will be complete and significant, that it will hold a variety of interests, that it will be strikingly portrayed; but, we further hope that new ideas will originate and prove that the magazine still represents the work of a progressive, serious organization.

The Senior Managing Board of Volume XXII will be Charles A. Speas, '42, General Manager; A. Carleton Jealous, '42, Editor-in-Chief; and George M. Watters, '42, Business Manager.

The Junior Managing Board will consist of three Associate Editors, Leo Feuer, '43, Jack Sibley, '43, and Donald Powers, '43; Associate Editor in Charge of Photographs, James Broderick, '43; Publications Editor, James Harker, '43; Personnel Manager, Read Stevens, '43; Circulation Manager, Robert Schede, '43; Art Editor, Dexter Wells, '42; Contributing Art Editor, Edwin Van Sciver, '42; Advertising Manager, Jack Karstrom, '43; Associate Advertising Manager, Charles Gates, '43; Publicity Manager, David Taylor, '43; Treasurer, Robert Rumsey.

Nineteen members of the Class of '44 will form the Freshman Editorial and Business Staff. Positions on the Editorial Staff are being taken by Robert Doak, Stanley Felix, William Heyser, Paul Heilman, David Jealous, Robert Nobles, Judson Stiles, Richard Weedon, Alan Michaels. The Business Staff is composed of William Abbott, William Boschen, Lee Eagleton, Norman Greenman, Bruce Kingsbury, William Murray, Trigg Noyes, Beverly Tucker, Frederick Lehman, Thomas Lawson.

ENGINEER SHORTAGE

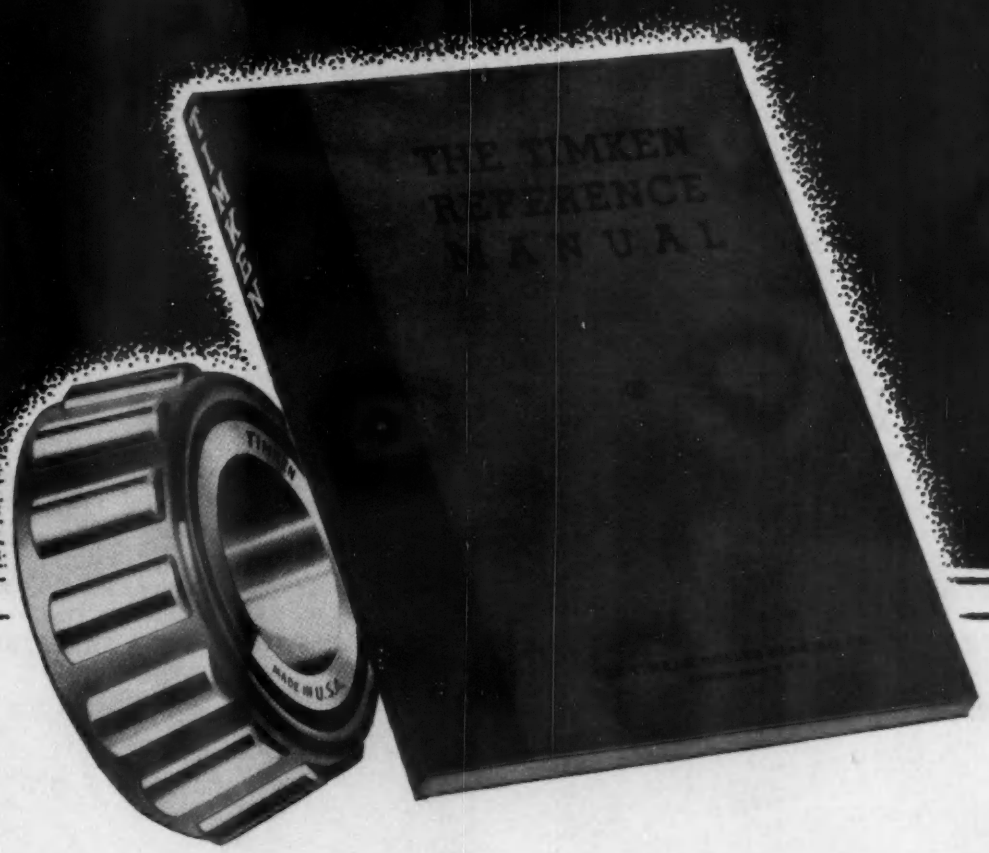
Certain defects in America's industrial organization have been brought to light by the stress which the Government has placed on the facilities of industry. The labor strife, "bottle neck," and other familiar terms are discouraging words to the formerly complacent American; such difficulties only serve to remind the more wary individual that equipping America is to be no small task.

The shortage of technically trained men in industry is the problem which invites the attention of the engineer especially. Certain important aspects of this difficulty are presented in a report given by the New York Committee on Engineer Training for National Defense. *Science News Letter's* discussion of this report is reprinted here in part. Points brought out in the portion reprinted are representative of those phases of the problem which should interest the engineer:

"Government and educators alike are alive to the serious situation. A report by the New York Com-

(*Continued on page 350*)

The TIMKEN Reference Manual will help to make you a better Engineer



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AIRLINE ENGINEERING COMES OF AGE

(*Continued from page 343*)

worthy by these performance standards, and to conduct research flight tests in the development of improved aircraft and accessories. After an airliner has undergone some engineering change, such as a change to a new type of propeller, engine, or engine accessory, it is often necessary to conduct flight tests to determine what change in flight characteristics and performances has been made by the new units. These flight tests must determine whether or not the aircraft is still within the performance standards, and whether the engineering change would be justified for the entire fleet of airliners. The engineer in charge of the flight testing must determine what flight maneuvers will be necessary to obtain the desired data, and then conduct the tests and supervise the recording in flight of the data. After the flight, the data must be corrected to standard conditions and analyzed. This correction to standard atmospheric and other conditions must be made in order that the tests can be compared directly to past and future flight tests.

In addition to taking care of these current needs of the airlines, the engineers must keep abreast of many developments taking place in the aircraft industry. Engineers are frequently sent out on field visits to become acquainted and maintain contact with the progress of the developments relating to the operation of an airline. These visits may constitute an inspection of new equipment under construction, or they may concern the development of some accessory to airline operation. As a result of this "visiting" the airline engineers become well acquainted with other engineers associated with aircraft and engine development.

Not quite as directly associated with the engineering department as the previously mentioned problems, are a large number of matters that directly concern other departments and are brought to the engineering department for consultation. The sales department wants a new instrument devised to quickly handle the sale of tickets at the counter, and the publicity department wishes to know what contrasts they can make between automobile and aircraft engines for a joint advertising campaign with a gasoline company. These problems and numerous others add together to make the airline engineer's job varied as well as interesting.

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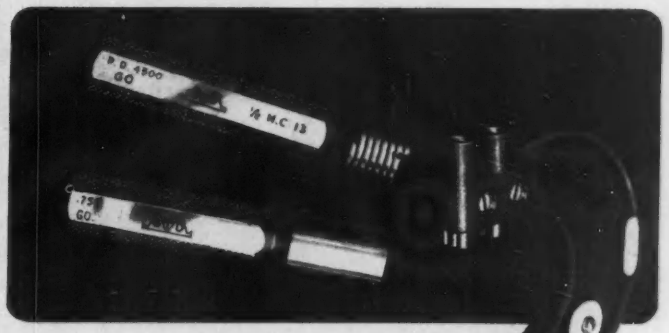

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TECHNOLOGY'S WIND TUNNELS

(*Continued from page 341*)

by seven and a half feet) testing chamber fifteen feet long, the balanced beams transmit the force readings of the model in "flight" to an electrically controlled panel in the adjoining building.

Models used in this large tunnel are made of wood and steel and may have wing spans up to eight feet; these models may cost many thousands of dollars in themselves. At present, equipment has just been installed for experiments on models having propellers powered by electric motors. Very little concerning wind tunnel research has appeared in print, since the present research is restricted almost entirely to national defense requirements.

The most recent of all tunnels at M. I. T., however, is the five by seven-and-one-half foot tunnel now under construction in the basement of Building 33. Built almost entirely of wood, this new 100 horse power system replaces the 1922 model described earlier and will be used for research on wing flutter.*

With increased speed of flight, development of streamlining, and high altitude flying, the importance of wind tunnels to aeronautics has increased greatly. The National Advisory Committee for Aeronautics boasts a full scale tunnel at Langley Field, Virginia; among universities, the Guggenheim Aeronautics Laboratory at California Institute of Technology has been a leader in the field. Perhaps the most recent development is the Northrup Aircraft corporation's tunnel at Los Angeles, one of the first to be operated by private industry. Even now, the Army Air Corps is building a "super wind tunnel" about which little information has been released.

The services which M. I. T. offers in the form of available facilities for use in air flow research make possible the analytical study of turbulence, "skin friction," flow separation, airfoils, and propellers. This study has been of great aid in promoting progress in aeronautics during the past years, and today the results of this air flow research are being utilized to meet certain requirements brought about by the defense program.

* More detailed information can be found in "Wind Produced Vibrations," December 1940.

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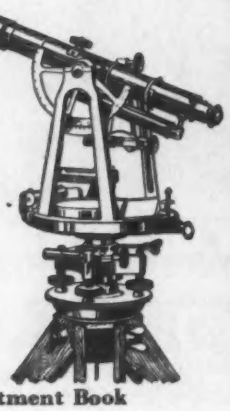

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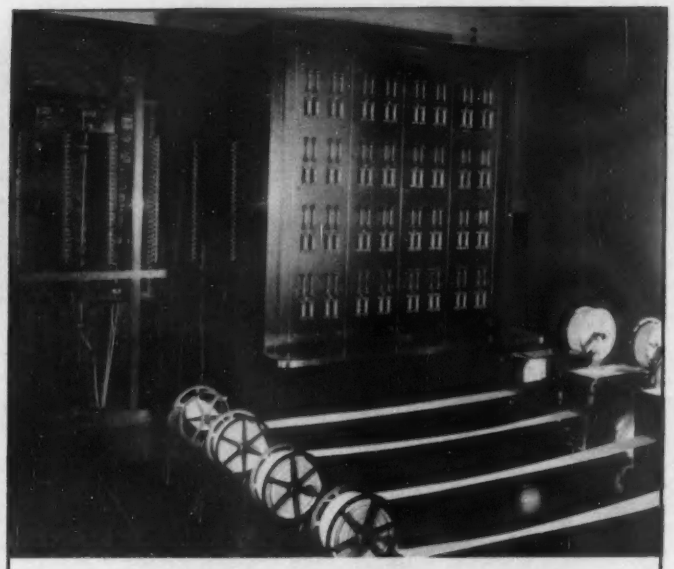

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American Airlines

EDITORIALS

(*Continued from page 346*)

mittee on Engineering Training for National Defense just issued, is the latest evidence that the nation faces a lack of technically trained men so critical that unless emergency measures are taken the defense program, hardly under way, will suffer.

"Aircraft production in the New York area alone, only 21 companies employing 38,300 men or a fraction of the total aviation industry, will need 6,000 new engineers within the next year, whereas all the engineering schools of the nation will turn out only 12,000. In non-aviation industries of the New York—New Jersey area, 1,500 more engineers will be needed, which is more than the engineering colleges in the area can provide."

Possible solutions are suggested in the discussion:

"An attempt may be made to discover engineering graduates in other lines of work and return them to engineering work.

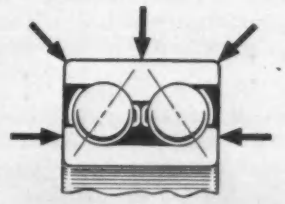
"Engineering colleges may hold classes during the summer and graduate in February engineers who otherwise might finish in June.

"Schools in the shops themselves may be established to allow employees to fit themselves for better jobs.

"In some areas public technical high schools are being used almost on a 24-hour basis to train mechanics to meet the expanding defense program. The engineering colleges may in the next few months find themselves providing the same service for technical engineering education."

MODERN machine design, encountering combination loads, intensifies the need for truly accurate and permanent location of revolving parts. Yet sound and economical construction in many instances does not indicate the use of two or more bearings to resist both radial and thrust loads.

Designers and engineers meet this situation readily, effectively and economically by specifying the *ball* bearing. For the ball bearing—and only the ball bearing—will properly resist loads from all directions and in all combinations.



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ENGINEERING STUDENTS: For interesting brochure, "Better Bearings—Better Machinery," write to New Departure, Division of General Motors, Bristol, Connecticut.

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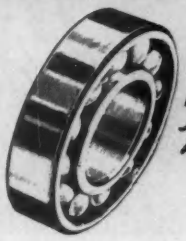

BALL BEARINGS

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PASSENGER COMFORT AT 15,000

(*Continued from page 340*)

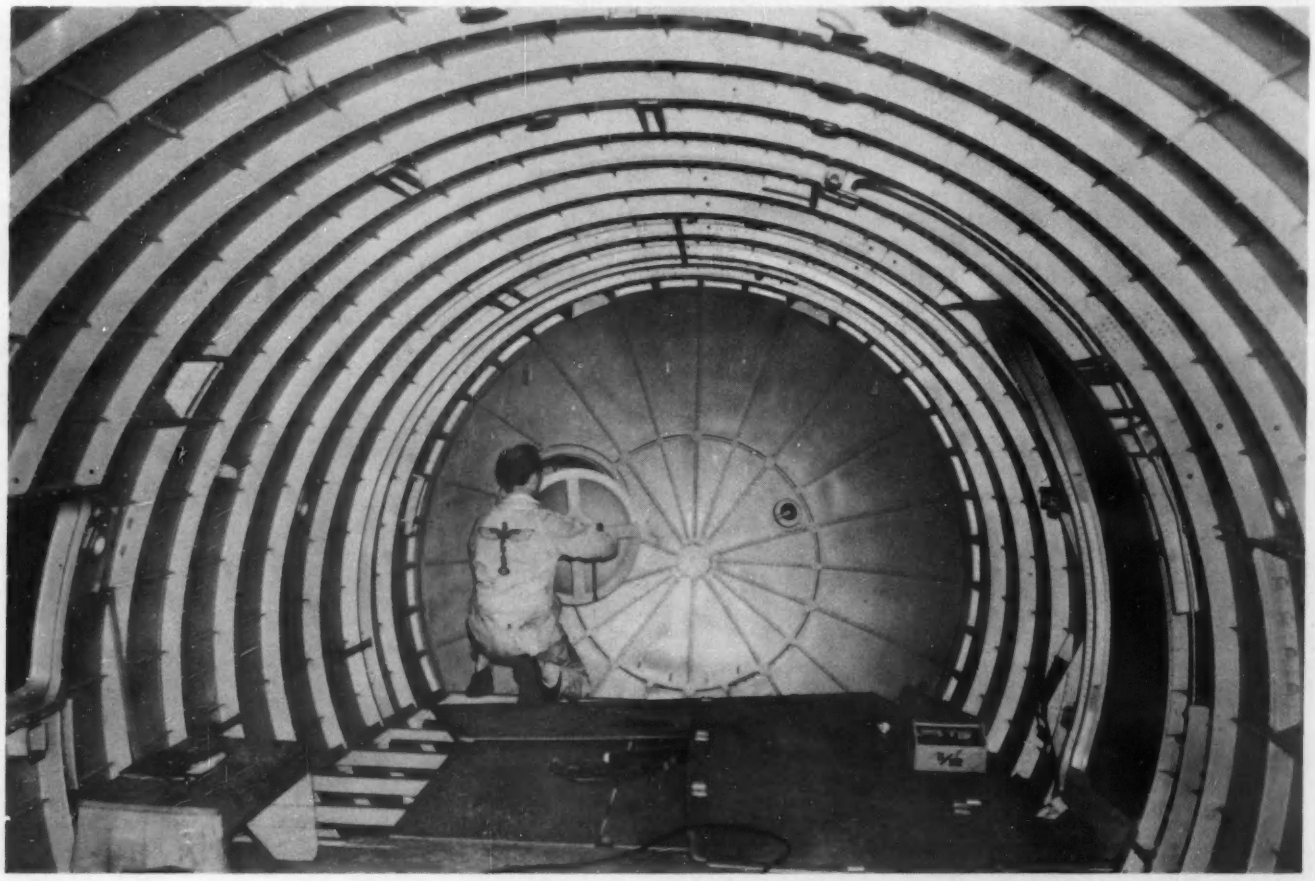
flight compartment on the right hand side of the cockpit. The pressure-cabin instruments are mounted on this panel in a group by themselves, separated from the surrounding instruments. In this group and at the lower left is a supercharger discharge pressure gage and a two-way selector valve for connecting the gage to the right or to the left supercharger in order that the pressure rise may be known. On the right is a suction gage with a three-way selector valve connected to it. When the latter valve is in the central position, the suction gage indicates cabin pressure referred to outside pressure. When the valve is in the left or right position, the suction gage indicates depression in the throat of the flow-measuring venturi of the right or of the left pressure air supply system. A selector valve is located in the uppermost portion of the panel for the purpose of manually selecting operation on either the right or left outlet valves, or both as desired. Below this space a vertical speed indicator, referred to cabin pressure instead of to atmospheric pressure, indicates the rate of cabin pressure change in terms of feet per minute. Next to this gage is an apparent-altitude green warning light to inform the engineer of the absolute pressure in the cabin. The green light can be pre-set by a knob below it to shine at consecutive apparent pressure altitudes of 8,000, 15,000, and 18,000 feet.

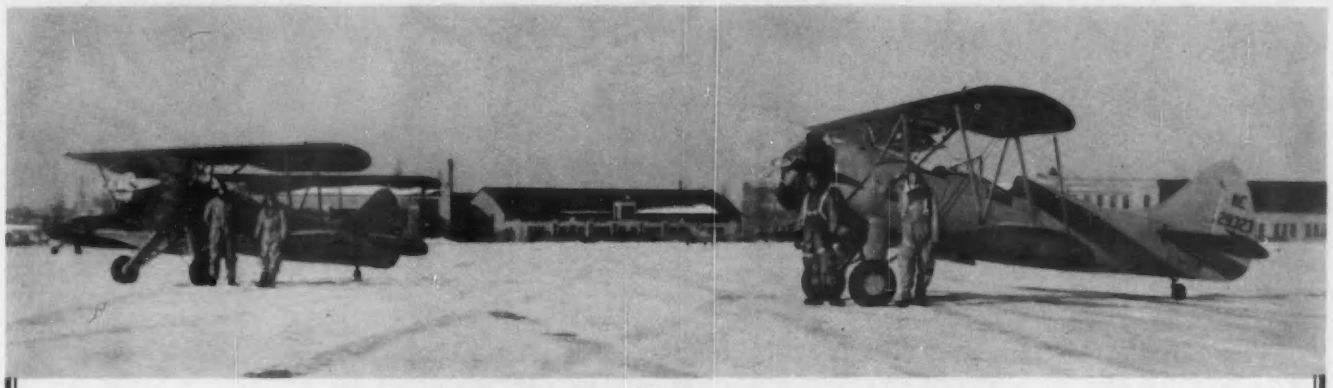
The air to be compressed is drawn from an inlet in the leading edge of the wing adjacent to the wing fillet. From there it passes through a water separator, through the supercharger which is driven by the engine, through the steam radiator in the leading edge of the wing, through an intercooler to reduce the temperature of the air, through the inflow control regulator, on through the cabin, out of the cabin through the floor into the compartments under the floor, and then through the outflow valve which is incorporated in the unit containing the inflow valve.

If the cabin temperature is too cold, feedwater pumps supply water to the boilers and these in turn supply steam to the radiators, thus raising the temperature of the incoming air passing through the radiator. If the cabin temperature is too high, the feedwater pumps do not operate; consequently the air passes through the cold radiator and the intercooler. On warm days during supercharged operation, the supercharger discharge temperature is such that it is necessary to operate with the intercooler valves open for maximum cooling.

The inflow of pressure air is fixed by the automatic controls at an impact value corresponding to the impact produced by 250 cubic feet per minute per blower at sea level. Except for changes due to cabin leakage, the flow value is unaffected by changes of other conditions, such as blower speed. The absolute pressure in the cabin is maintained substantially constant between 8,000 feet and 15,000 feet pressure altitude. At altitudes higher than 15,000 feet, the differential pressure of the cabin referred to the atmosphere is automatically held at approximately 2½ pounds per square inch, resulting in an apparent cabin altitude of 11,000 feet at an actual altitude of 19,000 feet.

A construction view of the interior of the Boeing Stratoliner, looking aft toward the entrance door on the left, and the pressure bulkhead which seals the rear end of the semi-monocoque circular passenger cabin. *Boeing Aircraft*





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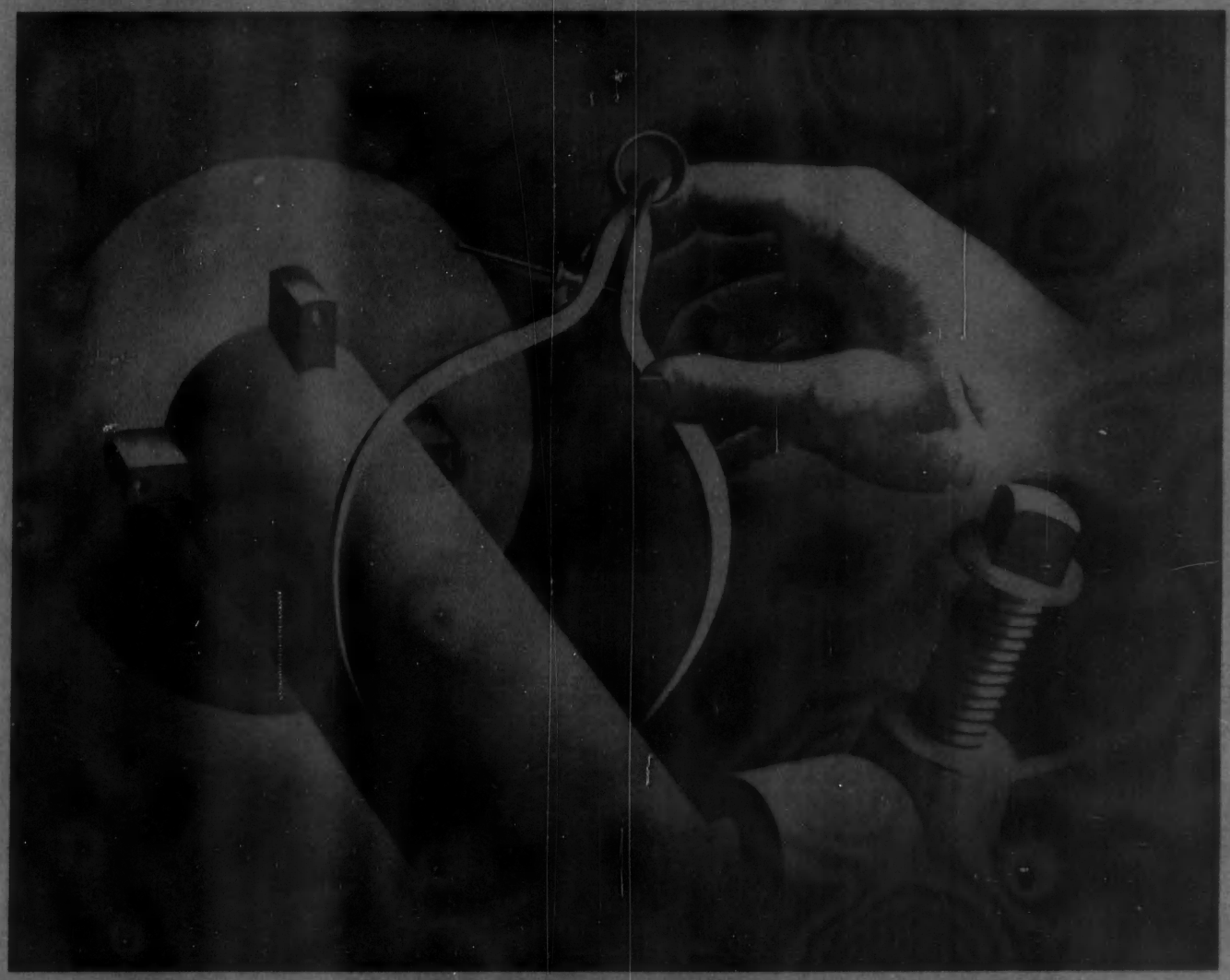

WHEN PRECISION GUARDS PRECISION

It is an old saying that "it's a poor workman who blames his tools". But shop foremen know that even the best operator cannot turn out precise and well finished work on a lathe with worn or faulty headstock gears.

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G-E Campus News

STOP THIEF!

BURGLARS and other criminals can no longer hope that bad radio weather will increase their chances of a getaway by gumming up police radio. Atmospheric disturbances, ignition noises, street car interference—in fact all the reception devils that plague the life of radio police practically disappear with the introduction of frequency modulation, the new method of broadcasting developed by Major E. H. Armstrong. Several two-way FM installations have already been made. One of the first was in Douglas County, Nebraska, which recently installed a number of G-E transmitters and receivers.

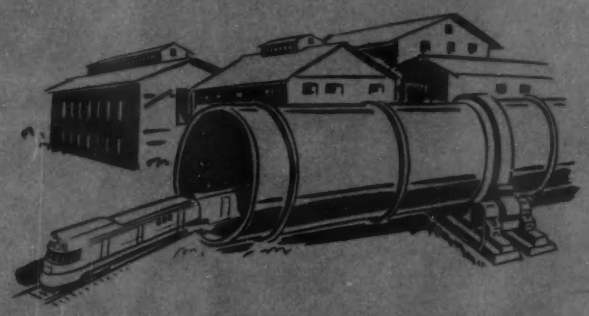
Among those responsible for many of the G-E developments which have made two-way FM possible are I. R. Weir (Rose Poly, '21) and H. P. Thomas (Harvard, '25)—transmitter engineers; and W. C. White (Columbia, '12) and K. C. DeWalt (Iowa, '27)—vacuum tube engineers.

GREASED LIGHTNING

THIRTY-ONE hundred revolutions a minute is lightning fast all right. But when a bearing revolving at that speed makes more noise than a boiler factory and coasts to a stop in 12 seconds, then it's time to look for a good lubricant. There's a catch though; the bearing is a part of an x-ray tube and operates in a high vacuum. The tendency of oil and grease to vaporize under these conditions makes it impossible to use ordinary lubricants.

So G. E. X-Ray Corporation engineers Atlee (Oregon State, '29), Filmer (Armour Tech, '31), and Wilson (College of Emporia, '31) set to work and developed a new lubricant—barium. When a thin film of this metal was applied to the bearing, its speed rose to over 3500 rpm, the noise of operation was materially reduced, and the coasting time was increased to eight minutes.

The benefit of these young men's research is not limited to the x-ray field alone, for their findings will apply equally well in all cases where rotating devices operate in a vacuum.



GARGANTUAN GARAGE

IF Burlington Railroad officials would give their permission, you could drive their Twin Zephyrs into the newest kiln of the Permanente cement mill in California and still have enough room left over for a large freight car.

This cement kiln, one of the largest pieces of rotating machinery in industry, measures 450 by 14 feet. It will be used in furnishing 6,000,000 barrels of cement for the construction of Shasta Dam.

The kiln will be driven by a 200-hp G-E motor—the largest ever built for this purpose and representing an innovation in design as well as size.

The big motor was tested by young engineering college graduates taking the General Electric Test Course at Schenectady.

GENERAL ELECTRIC

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